PERIODICAL ROOM
GENERAL LIBRARY
UNIV. OF MICH.

FEB 29 1936

SCIENCE

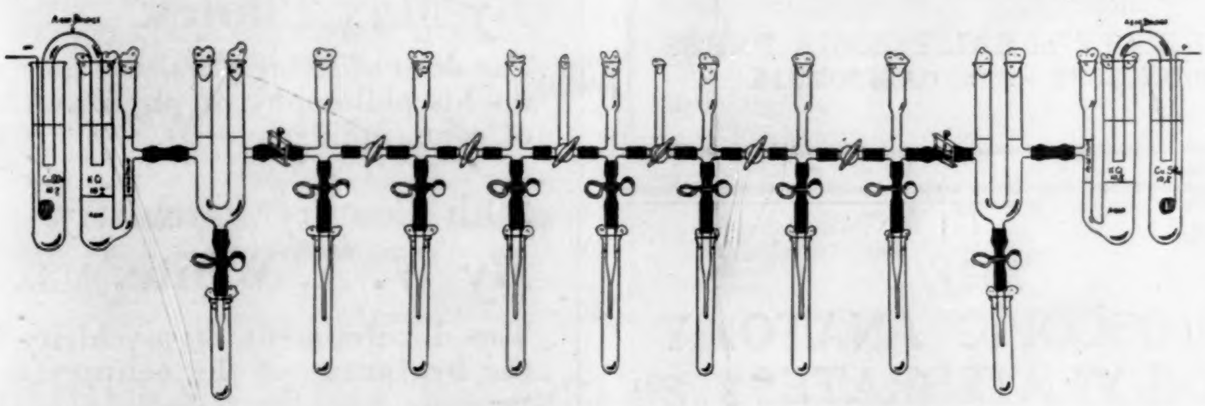
New Series
Vol. 83, No. 2148

Friday, February 28, 1936

Subscription, $6.00
Single Copies, .15

PACKCHANIAN
ELECTROPHORESIS APPARATUS

For the Isolation of Certain Protozoa from a Mixture of Bacteria and Protozoa, and for the Studying of Electrical Charges and Velocities of Filterable Viruses.



Consists of a series of cells which can be easily isolated from each other thus facilitating seven or more definite samplings from anodal and cathodal sections without diffusion of liquid. Apparatus can be sterilized.

Write for further information and prices.

EIMER & AMEND

Established 1851 **Incorporated 1897**

Headquarters for Laboratory Apparatus and Chemical Reagents

Third Avenue, 18th to 19th Street

NEW YORK, N. Y.

Entered as second-class matter July 18, 1923, at the Post Office at Lancaster, Pa., under the Act of March 3, 1879.

First Authorized English Translation

Theodor Brinkmann's

ECONOMICS
OF
THE FARM BUSINESS

With an introduction and notes by Elizabeth Tucker Benedict, Heinrich Hermann Stippler, and Murray Reed Benedict.

Now available to students of agricultural economics and farm management, for the first time, in English.

Pp. ix + 1–163 index

Social Science Research Council
Advisory Committee on Social and Economic Research in Agriculture.
Translation Series, No. 2

Price, cloth, $2.00

Published by

UNIVERSITY of CALIFORNIA PRESS
BERKELEY : : CALIFORNIA

NEW WORK *JUST READY*

THE MICROSCOPIC ANATOMY OF VERTEBRATES

By GEORGE G. SCOTT, Ph.D.
Professor of Biology in the City College, New York City

and JAMES I. KENDALL, Ph.D.
Instructor in Biology in the City College, New York City

Octavo, 306 pages, illustrated with 167 engravings. Cloth, $3.75, net.

This is a college text-book in comparative vertebrate histology, sufficiently condensed to be covered in a single semester period. To this end it has been kept primarily on a descriptive basis to accompany laboratory work. An objective is the mastery of technique and an important chapter on this topic is included. Unlike most texts in anatomy and embryology, the emphasis is not placed on human material but on a variety of vertebrates so that the book may truly serve as a survey of comparative microscopic anatomy and histology.

LEA & FEBIGER
WASHINGTON SQUARE
PHILADELPHIA, PA.

ANNOUNCING

The Phenomena of LIFE

A Radio-Electric Interpretation

By
George Crile

After years of research Dr. Crile at last has found a clue to the fundamental nature of living processes. In this book he presents his theory which suggests a physical line of ascent from atom to man, the argument to support that theory and the experimental data on which it is based. Illustrated. $3.50

The Philosophy of Physics

***By* Max Planck**

The dean of living physicists here sums up his philosophy of physics. A work of commanding interest. $2.00

20th Century Psychiatry

***By* W. A. White, M.D.**

The development of psychiatry from the beginning of the century to the present. $2.00

Men of Science

***By* J. G. Crowther**

The absorbing story of five great scientists, Davy, Faraday, Thompson, Joule, Maxwell, who revolutionized the course of science throughout the world. $3.50

Those Were Good Days!

***By* Carl L. Schleich**

The lively memoirs of the world-famous surgeon who was the pioneer in local anesthesia. Illustrated. $3.50

W. W. NORTON & CO.
70 Fifth Avenue, New York

o. 2148

SCIENCE

VOL. 83 FRIDAY, FEBRUARY 28, 1936 No. 2148

SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. MCKEEN CATTELL and published every Friday by

THE SCIENCE PRESS

New York City: Grand Central Terminal

Lancaster, Pa. Garrison, N. Y.

Annual Subscription, $6.00 Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.

PROBLEMS AND PROGRESS ON THE GEOLOGICO-SEISMOLOGICAL FRONTIER[1]

By Dr. JAMES B. MACELWANE, S.J.

PROFESSOR OF GEOPHYSICS AND DIRECTOR OF THE DEPARTMENT OF GEOPHYSICS OF ST. LOUIS UNIVERSITY

THE recent organization by the American Geophysical Union of two cooperative committees of national scope, the Special Committee on the Geophysical and Geological Study of Ocean Basins, under the chairmanship of Professor R. M. Field, and the Special Committee on the Geophysical and Geological Study of Continents, under Professor W. T. Thom, points unmistakably to a growing realization of the convergence and interdependence of geology and geophysics. And what is said of geophysics in general is particularly true of seismology. Hence the speaker thought it would be of interest to this joint meeting of geologists and seismologists to take our stand as it were on an eminence and survey the wide stretch of frontier between the two sciences and attempt to chart the progress of the two converging groups of explorers. There are times when even the formulation of a problem from two different points of view is an advance toward its solution. In any case it is well to take stock of fact and probability, of established theory and working hypotheses and to attempt to locate ourselves with some precision on the map of research.

In the brief compass of an address it is obviously impossible to qualify one's statements adequately; but if some of my statements seem to you so incomplete

[1] Address of the retiring vice-president and chairman of the Section of Geology and Geography of the American Association for the Advancement of Science, delivered at a joint session of the section and the Seismological Society of America, St. Louis, December 30, 1935.

as to be misleading or so categorical as to seem dogmatic or so one-sided as to appear unfair, I hope you will challenge them vigorously.

Geologists and seismologists are on exactly the same footing when looking into the depths of the earth. Both must observe from the surface. The difference lies partly in the methods and instruments with which they carry on their exploration, but partly also, and perhaps principally, in the frame of mind and the background of specialized training with which they approach the same problems. The geologist is trained to observe facts as they present themselves in the field and to balance them against alternative hypotheses; but he does so in a somewhat qualitative manner, for he depends largely on cumulative probabilities for his final decisions. His background usually will be mineralogical and petrographical; it will be physiographical, stratigraphical and frequently paleontological; but it will seldom be physical and mathematical. On the other hand, the geophysicist, generally speaking, whether he is working in pure seismology or in the applied and economic phases of the subject, will nearly always have come into the field with a background of physics and mathematics. This rigorous training makes him psychologically dissatisfied with observations and hypotheses in which there are too many variables. He wishes to isolate the phenomena and to devise instruments for the precise measurement of each. Indeed, he is restless until he can apply instrumental methods and can formulate a mathematical theory that will enable him quantitatively to correlate his observations and to predict further relationships. As fundamentally a physicist, he instinctively seeks to reduce field methods to such simplicity and precision that he can substitute a closed system in his laboratory and reproduce his results at will. Now it seems to me that it is the interplay of these radically different outlooks and of the consequently divergent methods that has proven most fruitful in unraveling some of the apparently hopeless tangles of earth structure.

The most accessible part of our earth is its outer crust; yet this very outer crust bristles with unsolved problems. Geologists have been accustomed to speak of the zone of fracture near the surface of the earth and of the underlying zone of flow. Now it has been found that the depth of first yielding in most destructive earthquakes is not, as might be expected, near the top of the zone of fracture but is at or somewhat below its base. The *normal* depth of focus of earthquakes or depth of first significant radiation of earthquake waves seems to be between ten and fifteen kilometers. Does this first sudden failure take place by faulting properly so-called? Branca, Conrad, Krumbach and Oldham[2] have suggested that thermodynamic causes may be at work even in ordinary earthquakes and that geologic faulting may not tell the whole story. On the other hand Wood[3] presented evidence that volcanic earthquakes as well as volcanic eruptivity itself may be largely controlled by tectonic factors. The problem is complicated by the necessity of explaining both the truly plutonic earthquakes to which we shall refer later in this address and also the large-scale surface faulting that has clearly been caused by certain great earthquakes, such as those of central California (1906), Owens Valley (1872), New Zealand (1855), Tango, Japan (1927), Pleasant Valley (1915) and many others. Furthermore, calculations have been made by Nakano, Byerly, Hasegawa and Gräfe[4] that seem to indicate the possibility, at least in certain favorable cases, of determining from the direction of motion at the beginning of certain phases in the seismograms of earthquakes recorded at distant points not only the fact that faulting occurred at the origin but even the orientation of the fault plane and the direction of slip. It seems clear, then, that the problem of earthquake causes is more of an open question than ever.

Closely related to the origin of earthquakes is the structure of the earth's crust. The interest of geologists and seismologists alike converges on seismic measurements at the surface of the earth where observations and interpretations can be checked by the examination of actual rock exposures and by the drilling and coring of wells. It is in the outer region of the earth's crust that those triumphs of seismic prospecting have been scored which are so numerous and so well known to you as need no description here. But these very successes were generally based on empirical and often on *ad hoc* solutions of the problems that arose in the process. What is, for example, the true significance of the so-called "weathered layer"? A much more scientific approach to the same problems than seemed to be possible in commercial work was naturally made in such independent investigations as those of Gutenberg, Wood and Buwalda in various parts of California,[5] Reich,[6] Barsch,[7] Korte[8] and

[2] W. Branca, *Sitzungsberichte der K. Preussischen Akademie der Wissenschaften, Mathematisch-physikalische Klasse*, 28: 380–399, 1917; V. Conrad, *Gerlands Beiträge zur Geophysik*, 20: 276, 1928; G. Krumbach, *ibid.*, 30: 361–364, 1931; R. D. Oldham, *Jour. Geol.*, 34: 385–398, 1926.

[3] Harry O. Wood, *Bull. Nat. Research Council*, No. 90, pp. 9–31.

[4] H. Nakano, *Seismological Bulletin of the Central Meteorological Observatory of Japan*, 1: 92–120, 1923; P. Byerly, *Am. Jour. Sci.*, 16: 232–236, 1928; M. Hasegawa, *Gerlands Beitrage zur Geophysik*, 27: 102–128, 1930; H. Gräfe, *Zeits. für Geophysik*, 9: 31–43, 1933.

[5] B. Gutenberg, H. O. Wood and J. R. Buwalda. *Bulle-*

others in Germany, Gutenberg in Wyoming, Ewing on the Atlantic continental shelf, and others. Seismic prospecting methods are of most use, of course, in regions where the successive formations are poorly exposed but have strongly contrasting elastic properties.

Important as are the thickness, character and structural attitudes of the sedimentary layers from the standpoint of geology and of applied geophysics, these surface formations shrink into insignificance in comparison with the so-called granitic and basaltic layers in their effects on the transmission of earthquake waves. Why this should be true becomes clear when we reflect that a structure must be large or at least of the same order of size in comparison with the length of a particular wave or group of waves in order to produce reflection or refraction. Now the velocity of longitudinal elastic waves in dense limestone and in granite is found to be five to six kilometers a second and the periods of the same type of earthquake waves are one to twenty seconds. Hence, the wave-length of these earthquake waves, which is given by the product of the period and the velocity, will vary from five or six kilometers to more than one hundred kilometers. The wave-lengths that are used in seismic prospecting are incomparably smaller, ranging in general from a few millimeters to several meters. The waves from larger commercial blasts are often of intermediate length.

Therefore, it is obvious that the relatively long waves radiated by natural earthquakes are only suitable for the study of the coarser crustal structure or large scale layering and not for determining the fine structure or the folding and faulting and the succession of sedimentary formations near the surface. This must be clear because the only means a seismologist has of characterizing a layer is by the velocity with which it transmits elastic waves; and the only way in which he can locate the boundaries between layers is to observe the phenomena of reflection, refraction and diffraction of elastic waves which occur only when the conditions are such that the boundaries form relative discontinuities; that is, when these boundaries mark *relatively sudden* changes in the velocity-depth ratio for a train of elastic waves of given wave-length. On the other hand, the energy required to penetrate the entire crust and give useful records of reflection and refraction by structures at depths greater than a very few kilometers is so enormous that only natural earthquakes can be relied on to furnish it. If the material composing the layer can be considered isotropic, so that its properties are independent of direction, then the thirty-six elastic constants of the general case reduce to two; and the types of possible body waves reduce also to two—the longitudinal type, in which there are propagated only alternations of irrotational change of volume, and the transverse type, which involves only equivoluminal shear. There are two ways in which the velocity of these two kinds of elastic waves in a particular type of rock can be determined. The one is a direct measurement, as, for example, by observing the vibrations from an artificial source, such as a blast of explosives, by means of a seismograph placed at a suitable distance on an exposure of the rock in place. The other method involves calculation from the elastic constants and the density of a specimen of the rock as measured in the laboratory. As is well known, the square of the wave velocity is equal to the ratio of the respective elasticity to the density of the rock. In the past it was always found that velocities measured in the field were greater than the velocities calculated in the laboratory, so that there arose an hypothetical distinction between static and dynamic constants based on the obvious differences between the application of slight forces for a very short time in the passage of an earthquake wave and the heavy static loading of the specimen in laboratory measurements.[9] This distinction was shown to be correct when the magnetostrictive vibration method was used by Muzzey and others,[10] and when an even more satisfactory electrostatic vibration method was devised and applied by Ide[11] to the same cylindrical rock specimens as had been used by Zisman. The elastic constants so determined gave velocities which agreed quite well with the field determinations. Nevertheless, the identification of completely concealed rocks by means of velocities alone without further evidence is so precarious as to be rarely justified; for, apart from the fact that radically different rock types such as limestone and granite may transmit elastic waves with the same velocity, it is reasonable to suppose with Daly[12] that the mineral composition of a given rock type will accommodate itself to the high pressures that exist in the deeper portions of the earth's crust. Hence it is only in the loosest possible sense of the word that we can speak, as do Jeffreys and others,

tin of the Seismological Society of America, 22: 185–246, 1932.

[6] H. Reich, Jahrbuch der Preussischen Geologischen Landesanstalt, 42, 1921.

[7] O. Barsch, Jahrbuch der Preussischen Geologischen Landesanstalt zu Berlin, 49, 1928.

[8] W. Korte, *Zeits. für Geophysik*, 7: 57–68, 1930.

[9] L. H. Adams and E. D. Williamson, *Jour. Franklin Inst.*, 195: 526–527, 1923; L. D. Leet and W. M. Ewing, *Physics*, 2: 168–169, 1932; W. A. Zisman, *Proc. Nat. Acad. Sci.*, 19: 680 and 653, 1933; L. D. Leet, *Physics*, 4: 375–385, 1933.

[10] D. S. Muzzey, *Phys. R.v.*, 36: 935, 1930; Giebe and Blechschmidt, *Annalen der Physik*, 18: 417–457, 1933.

[11] J. M. Ide, *Rev. Sci. Instruments*, 6: 296–298, 1935.

[12] R. A. Daly, "Igneous Rocks and the Depths of the Earth," p. 179, McGraw-Hill, 1935.

of a layer characterized by a given velocity as a granitic layer or a basaltic layer. The important point in the seismological evidence is not to be looked for in the assignment of rock types but rather in the fact that the deeper crust really seems to be composed of shells separated by rapid transitions or discontinuities and that the velocity increases from one shell to the next lower. A second contribution that is very valuable because exceedingly difficult consists in the more detailed working out of the crustal structure in individual regions. In Southern California, Gutenberg[13] found the structure very complex; so that, according to him, the crust there would seem to consist of at least four distinct shells of thickness 14, 11, 6 and 8 kilometers, respectively. In contrast with this 39-kilometer crust in Southern California, Byerly[14] finds but three layers in Central California and a total thickness of 31 kilometers. In further contrast, Hodgson[15] found but one crustal layer and a total thickness of only 16 kilometers in that central portion of the main island of Japan which is characterized by both normal and plutonic earthquakes. As evidence accumulates in regard to crustal structure the impression given is one of increasing complexity, almost of confusion. Before any certain conclusions can be drawn we must have a much greater body of evidence for a large number of regions. Such study can be prosecuted with great promise of fruit where there are a number of stations close together equipped with sensitive seismographs and recording with an open-time scale; and then only when earthquakes occur within the proper range of distance.

At the base of the crust there seems to be everywhere a major discontinuity, which has been named after the elder Mohorovičić, and below this discontinuity there does not appear, at present at least, to be convincing evidence for any other until a depth of about 970 to 1,000 kilometers is reached. What constitutes this great shell, or stone mantle, as it was called by Wiechert?[16] Is it a mass of crystalline ultrabasic rock or is it a glass? This much seems to be certain, that it transmits both types of earthquake waves with relatively high velocity and that this velocity on the whole, at least, increases rapidly with depth. This fact attests that it possesses a high degree of incompressibility and of rigidity for stresses that are applied for short intervals of time. It does not prove that it has the property of resistance to flow under long-continued strain. This latter property is called strength in counter-distinction to rigidity. Also, it is usually assumed that this shell is horizontally homogeneous and that the velocity of earthquake waves varies only with depth; but evidence has been presented by Dahm[17] which seems to indicate that the velocity at any given depth in the mantle varies slightly from region to region, and hence that there are regional differences of structure which extend far below the supposed level of isostatic compensation. Furthermore, this mysterious, intriguing mantle is the seat of plutonic earthquakes which have occurred at a wide variety of depths down to 700 kilometers and are frequently violent. In some of the deepest of these earthquakes the total energy suddenly released is enormous. This energy must have been stored as potential energy in some form or other. Two possibilities suggest themselves: the energy might have been stored chemically or it might have been stored as potential energy of elastic strain. The term chemical energy would naturally be taken in a wide sense to include latent energy of various types such as that of solution, melting, vaporization and of some forms of crystallization. It is conceivable that there might be aggregates at these great depths existing under forms that are in stable equilibrium only under other conditions of pressure and temperature than those proper to that level. It would not be unreasonable to suppose that this instability could progress to such a degree of unbalance that when the change of state or other reaction required to restore equilibrium occurred, it would take place with explosive violence. At least the work of Bridgman and analogies from the chemical laboratory would seem to point that way. If this were the explanation it would seem reasonable—almost necessary—to suppose either a recrystallization from an initial crystalline state or a change from a non-crystalline to a crystalline state. Granting that all thermodynamic and chemical difficulties could be removed, it is difficult to see how a purely explosive phenomenon propagated in all directions from a small nucleus could produce the enormous shear waves which we frequently observe in these earthquakes. In fact, there are some deep earthquakes in which almost all the energy seems to be in the shear waves. If, on the other hand, these enormous quantities of energy are stored in the form of potential energy of elastic strain two consequences would seem to follow: The first is that the energy must be stored partly and in some cases almost exclusively in shearing strain. The second consequence is that the medium itself must have

13 B. Gutenberg, *Gerlands Beiträge zür Geophysik*, 35: 6–50, 1932.

14 P. Byerly, Bull. Seismol. Soc. Amer., 25: 223–246, 1935.

15 E. A. Hodgson, Bull. Seismol. Soc. Amer., 22: 270–287, 1932.

16 E. Wiechert, "Nachrichten der K. Gesellschaft der Wissenschaften zu Göttingen, Math.-phys. Klasse," p. 427, 1907.

17 C. G. Dahm, Papers presented at the Ottawa meeting of the Eastern Section of the Seismological Society of America, May 27–28, 1935, and at the St. Louis meeting of the Seismological Society of America, December 30–31, 1935.

sufficient strength to allow the building up of such shear. Furthermore, it is difficult to imagine a mechanism which could introduce this shearing strain at depths presumed to be so far below the supposed level of isostatic compensation, unless it be recrystallization or some other change of state. Now we must suppose that at these depths changes of temperature and pressure can take place very slowly indeed. If the recrystallization or other change of state were to take place slowly but were to advance asymmetrically it is conceivable that the surrounding matter would be thereby distorted and that this distortion might progress to an extent that would involve the storage of the required quantity of energy in the form of potential energy of shearing strain before it would cause plastic failure, elastic rebound and the radiation of earthquake waves. Therefore the occurrence of violent earthquakes at depths of hundreds of kilometers within the mantle of the earth seems to suggest two ideas: *crystallinity* and *strength,* which are completely at variance with some otherwise very intriguing and plausible geological hypotheses such as that advanced by Daly.[18] Whether the facts can be explained on a purely thermodynamic basis, as proposed by De Lury,[19] or whether the deep-seated inhomogeneity suggested by Dahm's results points to the megadiastrophic ideas of T. C. Chamberlin,[20] it would be too early as yet to conjecture.

It seems to be fairly well established that the shell within which the velocity of earthquake waves increases rapidly and in which deep earthquakes occur is separated at its base from the underlying transition shell, in which the velocity varies but little with depth, by a second order discontinuity or thin shell of such rapidly changing properties as to reflect a part of the wave energy that falls upon it. To this discontinuity, which lies at a depth of 970–1000 km, the name of Repetti has been given because he[21] was the first clearly to demonstrate its existence and its depth by identification on the seismographic records of reflections produced by it and by the discovery of cusps in the functional curves derived from the observed times of arrival of earthquake waves affected by it. It is true that many years before a "peculiarity" at that depth was suggested by Geiger,[22] but no corresponding discontinuity appears in his published curves. Gutenberg and Richter[23] say: "This is actually the same discontinuity which was first discussed by Wiechert; the corresponding rays emerge at about the same distance as found by him. The decreased depth is due to the general improvement in observed travel times." But I think it will be clear to all who read the statements of Wiechert[24] that he is speaking of the boundary of a central metallic core and that his discontinuity is the one which was later shown by Gutenberg himself to lie at a greater depth than Wiechert had supposed. Thus, for example, Wiechert said in 1907: "Rather, it must be absolutely assumed that there are in the deep interior of the earth substances of greater specific gravity than on the earth's surface. It certainly seems natural to think that the stone mantle on which we live envelops a metallic core. We see at once where to look for its boundary; obviously at that depth of 1500 km, where so striking a change appears in the influence of the earth's substance on earthquake waves."[24] And in 1910 he wrote: "I was forced to see in the sudden change of the velocity-depth relation at 1500 km the boundary between the stone mantle and the metallic core which had been deduced from astronomical observations. Zoeppritz and I could find no indications of a discontinuity within the stone mantle, such as would have corresponded to the travel time curves of Milne and Benndorf."[22] The distance of emergence on the earth's surface of the rays concerned in Wiechert's supposed 1500 km discontinuity was 49°, which is quite different from the 33° found by Repetti, Witte and Dahm. The difficulties of investigation increase with depth, and much remains to be done before we shall have a satisfactory picture of the transition into the earth's core. The well-known phenomena of the shadow zone seem not to be nearly so simple as had been supposed.[25] The results of Dahm's[26] comparison of the depth of reflections with that attained by the grazing rays seem to indicate that there intervenes between the overlying material and the core proper a shell somewhat more than 200 km in thickness that plays an essential part in the production of the shadow zone.

While excellent contributions have been made toward the solution of the problem of the core, those who are working in the field would be the first to admit that their methods are indirect and their conclusions very tentative. No one has as yet discovered a direct method of measuring the velocities of seismic waves at any particular point or level within the core. The velocities and travel times that have been given, for example, by Gutenberg[27] were based on methods of

[18] R. A. Daly, "Igneous Rocks and the Depths of the Earth," pp. 173–213, McGraw-Hill, 1933; *Jour. Wash. Acad. Sci.*, 25: 389–399, 1935.

[19] J. S. De Lury, *Jour. Geol.*, 43: 759–764, 1935.

[20] T. C. Chamberlin, *Jour. Geol.*, 19: 391–415, 1931.

[21] W. C. Repetti, "New Values for Some of the Discontinuities in the Earth," 17 pp., Manila, 1930.

[22] E. Wiechert, *Physikalische Zeits.*, 11: 298, 1910.

[23] B. Gutenberg and C. F. Richter, *Gerlands Beiträge zur Geophysik*, 45: 347, 1935.

[24] E. Wiechert, *Physikalische Zeits.*, 9: 46, 1907.

[25] J. B. Macelwane, *Bull. Amer. Phys. Soc.*, 1: 4, 1925; H. Jung, *Nachrichten d. Gesellschaft d. Wiss. zu Göttingen*, Math.-Phys. Kl. 1933: 42–80.

[26] C. G. Dahm, Dissertation, St. Louis, 1934.

trial and error by which he set up twenty-eight alternative hypotheses and chose the one which seemed to him to accord best with the observed total travel times of outstanding phases. But he did not publish any demonstration that his solution was either unique or the best attainable from the data. Not until a direct method of attack on the core problem is found can we begin to discuss with confidence the distribution of velocities within the core or the probable characteristics of the material composing it. There seems to be evidence for the transmission of shear waves through the core, but this evidence raises new problems which call for direct attack. The transmission of shear waves would prove effective rigidity and consequent solidity in the popular sense, but would not prove solidity in the technical sense of the phase theory. In fact, the conditions at the center of the core would seem to transcend all possibilities of direct human experience. The temperature is completely unknown and the pressure is so enormous as to stagger the imagination. Unknown states of matter are not excluded.

In conclusion, it would seem that the entire picture of positive geological results attained by seismological methods, of the new problems thus realized and formulated, and of the better understanding and readiness to cooperate which is evidenced in the ranks of geologists and of seismologists, is a most encouraging one and foreshadows a new and exceedingly interesting era of geologico-seismological research.

OBITUARY

JAMES HARTLEY ASHWORTH

JAMES H. ASHWORTH, professor of natural history in the University of Edinburgh, died suddenly at his home in Edinburgh in the night of February 3–4, 1936. He had attended a meeting of the Royal Society of Edinburgh, of which he was general secretary, the preceding afternoon, at which meeting Professor H. S. Jennings, of Johns Hopkins University, who is this year George Eastman professor at Oxford, gave an address. In the evening he was present at a dinner in honor of Professor Jennings, who was a guest at his home. He retired for the night, weary but with no premonition of death; in the morning he was found cold and still.

Professor Ashworth was 62 years old. He was born in Lancashire, educated at Manchester University; and after he had taken the degree of D.Sc. at London, he was for four years lecturer and demonstrator in zoology at Manchester. For the past thirty-six years he had been associated with the University of Edinburgh, first as lecturer in invertebrate zoology, then as professor of zoology and for the past nine years as professor of natural history and administrative head of the department. His publications include memoirs on many groups of invertebrate animals, and the accuracy and value of his researches brought him important honors and awards, among them the Keith Medal of the Royal Society of Edinburgh; he was president of the Royal Physical Society of Edinburgh, a fellow of the Royal Society of London and member of its council. But it is probable that his most important contributions to science were in the fields of instruction, organization and administration. He was a conscientious and inspiring teacher and a particularly able organizer and wise executive. When he came to his professorship in the university he found the department of zoology inadequately organized and badly housed. He at once set about making improvements, with the result that his department is now of outstanding excellence. In 1923 a generous donor gave £20,000 toward the development of the department of zoology, in 1925 the trustees of the Carnegie Trust for the Universities of Scotland set aside £18,000 for this purpose, and at Christmas, 1926, the International Education Board of the Rockefeller Foundation appropriated £74,000 to carry out this project. The University Court in accepting these generous gifts "placed on record their sincere appreciation of the part which Professor Ashworth had taken in making possible this great development, and their recognition that the provision of funds adequate for the undertaking had been due in large measure to his personality and unsparing efforts." Sketch plans of the building were prepared by Professor Ashworth; construction was begun in June, 1927, and the building, which cost £80,000 and is one of the most complete laboratories of zoology in the world, was formally opened by His Royal Highness Prince George on May 15, 1929.

Professor Ashworth's interests were not limited to his own institution, but he was always ready to lend a helping hand to others. He was a trustee of the Bermuda Biological Station for Research and had been active in recent months in undertaking to raise funds in Great Britain for that institution. He was widely known in this country, where he had visited and lectured at universities and scientific institutions from the Atlantic to the Pacific. The gracious and charming personalities of Professor and Mrs. Ashworth are remembered by a host of American friends who lament his untimely death.

E. G. CONKLIN

[27] B. Gutenberg, "Nachrichten der K. Gesellschaft der Wissenschaften zu Göttingen, Math.-physikalische Klasse," pp. 28–29, 1914.

RECENT DEATHS AND MEMORIALS

CHARLES RUSSELL RICHARDS, formerly director of Cooper Union, New York City, and of the department of science and technology of the Pratt Institute, one of the founders of the New York Museum of Science and Industry, died on February 21, at the age of seventy years.

HIRAM PERCY MAXIM, the inventor of the Maxim silencer and of other implements of warfare, died on February 17. He was sixty-seven years old.

DR. MARCUS ADOLPHUS ROTHSCHILD, of the Beth Israel Hospital, New York City, specialist in heart diseases, died on February 16, at the age of forty-eight years.

DR. LYNNE HOAG, associate professor of pediatrics at the Cornell University Medical School, died on February 16. He was forty-three years old.

MISS GEORGIA COOPER, for twenty-one years a bacteriologist of the Department of Health, New York City, died on February 19, at the age of fifty-one years.

DR. P. P. VON WEIMARN, formerly of Empress Catharina Mining Institute of St. Petersburg, more recently head of the Dispersoidological Department of the Imperial Industrial Research Institute, Osaka, Japan, died in Shanghai on June 2, 1935, after a long illness. He was well known for his contributions to colloid chemistry.

As a memorial to the late Professor James H. Breasted, who died on December 2, the building housing the Oriental Institute at the University of Chicago has been named "James Henry Breasted Hall." The institute, erected at a cost of $1,500,000, was dedicated on December 5, 1931. It houses five museum halls, administrative quarters for the expeditions of the institute in the Near East, classrooms and offices for the department of Oriental languages and literatures and for such research projects as the compilation of an Assyrian dictionary, library and storage and preparators' quarters.

SCIENTIFIC EVENTS

COMMISSION ON NUTRITION OF THE LEAGUE OF NATIONS

THE Expert Commission on Nutrition appointed by the Health Committee of the League of Nations met on November 25 at the London School of Hygiene and Tropical Medicine. Those present were:

FRANCE.—Professor J. Alquier, directeur de l'Institut d'Hygiene Alimentaire, Paris; Professor L. Lapicque, professor of physiology at the Laboratory of Physiology, Sorbonne, Paris.

SCANDINAVIA.—Professor Axel Hojer, generaldirektor, Medicinalstyrelsen, Vallingatan 2, Stockholm.

UNITED KINGDOM.—Professor Cathcart, professor of physiology, University of Glasgow; Professor E. Mellanby, professor of physiology and biochemistry at the University of Sheffield, and secretary-general of the Medical Research Council, London; Sir John Boyd Orr, director of the Imperial Bureau of Animal Nutrition, Reid Library, Rowett Institute, Aberdeen.

UNITED STATES.—Professor E. V. McCollum, professor of biochemistry, the Johns Hopkins University; Dr. Mary Swartz Rose, Columbia University; Dr. W. Sebrell, chief of the Department of Nutrition, National Institute of Hygiene, Washington, D. C.

U. S. S. R.—Professor Sbarsky, director of the Central Nutrition Institute, Moscow.

The commission elected Professor Mellanby as chairman and Dr. McCollum as vice-chairman.

A statement was presented on the origin of the studies of the question made under the auspices of the League of Nations. After a general exchange of views the commission decided to draft a statement on scientific principles governing dietaries of certain population groups—namely, women during pregnancy and lactation, infants, school-children and adolescents up to the age of twenty-one years.

Two subcommittees—one on energy-producing substances, under the chairmanship of Professor Cathcart (members: Professors Alquier, Lapicque, Sbarsky and Sebrell, with Dr. McGee of the Ministry of Health as secretary), and the other on non-energy-producing substances (such as minerals, salts, vitamins, etc.), under the chairmanship of Professor McCollum (members: Professors Hojer and Mellanby, Sir John Boyd Orr, and Dr. Swartz Rose, with Dr. Harriet Chick of the Lister Institute as secretary)—were entrusted with the task of drawing up detailed recommendations which will be submitted to the plenary commission at a later meeting.

THE NATURAL HISTORY SOCIETY OF MARYLAND

ON the work of this society a correspondent writes as follows:

The Natural History Society of Maryland is an institution devoted solely to the natural sciences and is one of two institutions engaged primarily in scientific work in this state. The other, the Maryland Academy of Sciences, is a separate and distinct organization.

At present the Natural History Society of Maryland

is mainly a research institution, operating laboratories in mineralogy, paleontology, botany, marine life, entomology, herpetology, ornithology and Indian archeology. The greater part of this work is conducted in the field. It also has a broad educational program in the public and private schools, as well as in other institutions of the state. This work is conducted by a special department of education.

The organization has conducted expeditions in Haiti, Santo Domingo and the Bahamas, as well as in various parts of Maryland. Through these expeditions the society has added several new species and a genus to our fauna and has worked out, for the first time, life histories of a number of vertebrates. It has also discovered minerals hitherto unreported in Maryland and has unearthed new fossils.

At present the society is engaged in important projects of special interest to our state, a few of which will suffice to give some idea of their scope. For the past summer and fall, the department of marine research has been studying the life histories of the fish of the Chesapeake Bay and its tributaries, in connection with the Chesapeake Biological Laboratories at Solomons Island, Maryland. The undersea work is being done by utilizing an undersea tank called the "Bentharium" devised by two of the members.

In herpetology work is going on in conjunction with the American Museum of Natural History. Studies made in southern Maryland concern the courtship of the lizards.

A survey of the fossil life of the state is being carried on vigorously. For the past two years the work has been in the Eocene deposits. The Miocene has been completed after seven years of untiring energy.

A similar survey is being made of the insect life, and a leaflet is now in preparation on the butterflies as an accompaniment to the previously published leaflet on "The Familiar Moths of Maryland."

In botany, a check list is being compiled of our trees. A list of minerals has just been completed to be published shortly, and a like list is under way in ornithology; a check list of the birds of the State Forest Reserve is ready for publication.

For years the department of Indian archeology has been spotting our former Indian village sites, work in several of the counties having been so far completed.

The department of education, besides its program of school lectures, exhibitions, and loan material, will this spring open a Nature Trail of several miles, culminating in a Trail Side Museum in the Forest Reserve. This work is in cooperation with the State Department of Forestry and the Civilian Conservation Corps.

The publications of the society include a monthly bulletin (mimeographed), proceedings and guide leaflets.

PROFESSOR AMES AND PROFESSOR JACK OF THE ARNOLD ARBORETUM

THE following resolutions in appreciation of Professors Oakes Ames and J. G. Jack, respectively, who have retired from the Arnold Arboretum, Harvard University, were passed at a recent meeting of its staff. The resolutions are signed by Alfred Rehder, associate professor of dendrology and curator of the herbarium; J. H. Faull, professor of forest pathology, and Hugh M. Raup, research associate.

Professor Ames

Dr. Charles Sprague Sargent, the first director of the Arnold Arboretum, passed away in the spring of 1927. During the more than fifty years of his directorship he had established a unique, world-renowned institution, a great arboretum for the scientific study of woody plants. Hence a heavy responsibility rested on the administrators of Harvard University when it came to choosing his successor.

The choice fell on Professor Oakes Ames and he accepted the undertaking under the title "Supervisor of the Arnold Arboretum." The outcome has more than fulfilled anticipations. Beginning with a clear understanding of the functions and the policies of the arboretum, he has both successfully maintained the traditions of the arboretum and skillfully carried through a sound, progressive program of development.

While it may not be possible at this time to measure accurately the relative values of his various accomplishments, several unquestionably take rank as of eminent importance. At the very outset he led a movement among friends of the arboretum which quickly resulted in a large increase of its endowment. This enabled him to guide the arboretum safely through the many years of severe business depression which the country was soon to experience and at the same time to accomplish a remarkable expansion of its scientific activities. Among the latter, special mention should be made of the enlargement of the scientific work of the arboretum to include research in anatomy, ecology, genetics and pathology of woody plants. Likewise there was added to the arboretum a tropical station in Cuba and there was effected a working connection with the Harvard Forest. Finally, a warm, cooperative spirit was cultivated, expressed in part by the contribution of various courses to Harvard College that bound the arboretum more closely than ever before to the other biological interests of the university.

Noteworthy among other features of Professor Ames's incumbency as supervisor have been construction of new greenhouses and a laboratory for plant pathology on the Bussey grounds, the addition of many new plants to the outdoor collections and to the herbarium, the improvement of the physical condition of the grounds, a great enrichment of the library, a widening of the scope of the *Journal*, and the inauguration of a handsome series of memoirs under the title "Contributions from the Arnold Arboretum." Besides all of these there are certain intangibles that can only best be appreciated by those so fortunate as to be directly associated with him.

We, the staff of the Arnold Arboretum, gratefully express our recognition of these many services rendered by Professor Ames. We cherish the recollections of his supervisorship and our happy associations with him. We shall keenly miss the presence of his genial personality and the advantages of his wise counsels, and regret that

in lightening his load of official duties he has deemed it best to relinquish his fruitful connections with the arboretum. With his retirement as supervisor there is now brought to a close a second notable chapter in the history of the arboretum.

Professor Jack

After having been connected with the Arnold Arboretum for nearly fifty years, Professor J. G. Jack retired on October 1, 1935. On this occasion the staff of the Arnold Arboretum wishes to express its great appreciation of the efficient services he rendered to the institution during this long time. Coming to the arboretum in 1886, he saw it grow from modest beginnings to its present size and importance; in this development he played no small part and did his full share in the work. One of his chief duties was the keeping of the exact records of all the plants introduced into the ever-growing collections to which he himself added considerably. He was the first to introduce, during a voyage to the Far East in 1905, plants of the then little known flora of Korea, among them the handsome Korean azalea; he also brought back from collecting tours in the Rocky Mountains and the Pacific Coast many interesting trees and shrubs new to the garden. As teacher, consultant and lecturer, he succeeded in interesting a wide circle of men and women in the work of the arboretum and gained for it many friends who, in turn, were of great help to the institution financially and in other ways. More recently he played an important part in the development of the tropical branch of the Arnold Arboretum, the Atkins Institution of the Arnold Arboretum in Cuba; for a number of years he spent several months each winter in Cuba, collecting plants and seeds for the garden and creating an herbarium representing the flora of the surrounding country, which is of great help to the students of the university working there. The herbarium of the arboretum itself also profited greatly from his activity in Cuba and from his travels abroad and in this country.

We rejoice in his long term of fruitful and honorable connection with the arboretum and express our deep regard for him personally and for what he has meant to the institution. The members of the staff are pleased to see that after his retirement he has not lost interest in the arboretum but continues to help in its work, and they hope they will have the pleasure of seeing him here for many years to come.

SCIENTIFIC NOTES AND NEWS

THE presentation of the Catherine Wolfe Bruce Gold Medal of the Astronomical Society of the Pacific to Professor Armin O. Leuschner, of the University of California, was made on the evening of February 24. Dr. Seth B. Nicholson, of the Mount Wilson Observatory, made the presentation. Dr. Leuschner delivered an address entitled "The Story of Andromache—An Unruly Planet."

THE Lamme Medal of the American Institute of Electrical Engineers has been awarded to Dr. Vannevar Bush, vice-president of the Massachusetts Institute of Technology and dean of the School of Engineering, "for his development of methods and devices for application of mathematical analysis to problems of electrical engineering." The medal and certificate will be presented to him at the annual summer convention of the institute, which is to be held in Pasadena from June 22 to 26.

DR. PETER H. BUCK (TE RANGI HIROA), who was recently elected to succeed Professor Herbert E. Gregory as director of the Bernice P. Bishop Museum, Honolulu, has been awarded the Rivers Memorial Medal for 1936. The award is for "meritorious field work in physical and cultural anthropology."

THE Moulton Gold Medal of the London Institution of Chemical Engineers has been awarded to R. W. Powell and Dr. Ezer Griffiths for their paper on "The Evaporation of Water from Plane and Cylindrical Surfaces."

ON the occasion of the celebration of the sixtieth anniversary of the founding of the Johns Hopkins University on February 22, Dr. Isaiah Bowman made his first address as president of the university. There were no formal installation ceremonies. The honorary degree of LL.D was conferred on Dr. Irving Langmuir, associate director of the Research Laboratory of the General Electric Company; on Dr. Westel W. Willoughby, professor emeritus of political science at the Johns Hopkins University, and on Dr. William Holland Wilmer, until his retirement last year director of the Wilmer Institute of Ophthalmology.

DR. JOHN A. FLEMING, director of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington, was elected on January 21 a corresponding member of the Chr. Michelsen Institute of Science and Intellectual Freedom of Bergen, Norway.

DR. STEPHEN TIMOSHENKO, of the University of Michigan, has been appointed professor of theoretical and applied mechanics at Stanford University.

DR. E. V. APPLETON, Wheatstone professor of physics in the University of London and formerly fellow of St. John's College, Cambridge, has been elected to the Jacksonian professorship of natural philosophy at the University of Cambridge from October 1, 1936.

DR. WILBERT J. HUFF, head of the department of gas engineering of the Johns Hopkins University, has

been appointed chief chemist of the Explosives Division of the U. S. Bureau of Mines.

BRYAN PATTERSON has been made assistant curator of fossil mammals in the department of geology of the Field Museum of Natural History, Chicago.

WARD SHEPARD, formerly of the U. S. Government Forest Service and special adviser on Indian affairs, land policy and soil erosion in the Federal Departments of Interior and Agriculture, has been appointed director of the Harvard Forest for one year from May 1. The forest over which he will have charge consists of 2,300 acres of woodland in Petersham, about seventy miles from Cambridge.

W. K. BAILEY, recently a graduate student at the University of Maryland, has been appointed associate plant physiologist in charge of truck-crop investigations at the Puerto Rico Experiment Station of the U. S. Department of Agriculture. Charles Pennington, of the Colonial Technical Institute, Paris, has been appointed specialist in vanilla production and processing investigations at the Puerto Rico station.

DR. D. EWEN CAMERON, previously director of the outpatient department of the Provincial Mental Hospital, Manitoba, Canada, has joined the staff of the Research Service of the Worcester State Hospital.

PROFESSOR BALDWIN M. WOODS, head of the department of mechanical engineering of the University of California, has been appointed chairman of the tenth district, National Resources Committee, to coordinate the activities of planning boards in five western states.

LORD RUTHERFORD, Cavendish professor of experimental physics at the University of Cambridge, has been appointed director of the Royal Society Mond Laboratory until January 24, 1940.

DR. E. V. JONES, head of the department of chemistry at Birmingham-Southern College, is spending his sabbatical leave during the year 1935–36 as a visiting professor of chemistry for the first semester at Soochow University, China. The second semester he is spending in travel through India, Palestine and the principal countries of Europe. Before going to Birmingham-Southern College he had been for several years professor of chemistry at Soochow University.

DR. L. SLAUCITAJS, associate professor of geophysics, University of Riga, Latvia, arrived in Washington, D. C., on February 15, where he will be engaged during the spring and summer in the study of geophysical subjects at the Department of Terrestrial Magnetism of the Carnegie Institution of Washington.

DR. C. I. BLISS, formerly entomologist in the Bureau of Entomology of the U. S. Department of Agriculture, after two years of study with Professor R. A. Fisher in London, has been appointed for a three-year period as a specialist in Leningrad, where his work will deal with insect toxicology and the application of modern statistical procedures to the problems of applied entomology.

DR. EDWIN P. HUBBLE, astronomer of the Mount Wilson Observatory, has been appointed to deliver the Rhodes Memorial Lectures at the University of Oxford for the year 1936–37.

THE annual Alpha Omega Alpha lecture of the Jefferson Medical College was given on February 14 by Professor Walter Bradford Cannon, of the Harvard Medical School. His lecture was entitled "Serendipity."

THE sixth Harvey Society lecture will be given at the New York Academy of Medicine on March 10, by Dr. Richard E. Shope, associate member of the Department of Animal and Plant Pathology of the Rockefeller Institute, Princeton. He will speak on "The Influenzas of Swine and Man."

DR. FRANCIS G. BENEDICT, director of the Nutrition Laboratory of the Carnegie Institution of Washington, Boston, delivered an illustrated lecture on "The Physiology of the Elephant," before the Harvard Medical Society at the Peter Bent Brigham Hospital, on January 14, at the Department of Genetics of the Carnegie Institution of Washington, Cold Spring Harbor, N. Y., on February 10, and at the University of New Hampshire, on February 13.

THE third Harry Burr Ferris Lecture in anatomy at Yale University was given by Dr. Davenport Hooker, professor of anatomy at the University of Pittsburgh, on the evening of February 19. His subject was "Early Foetal Movements in Mammals." The lecture was illustrated by moving-picture sequences of the earliest reactions of embryos and young foetuses.

THE Columbia University Chapter of the Society of Sigma Xi will hold a meeting in Havemeyer Hall at 8 P. M. on March 3, when Dr. Leroy L. Hartman, professor of dentistry, Columbia University, will deliver a lecture on "Treating Sensitive Dentin of Teeth."

THE fifth lecture in the Smith-Reed-Russell series for this year at the School of Medicine, the George Washington University, was given on February 18 by Dr. Esmond R. Long, of the Henry Phipps Institute in Philadelphia. The subject of his address was "Types of Pulmonary Tuberculosis in Relation to Spread of the Disease."

DR. THORNTON C. FRY, mathematician of the Bell Telephone Laboratories, New York City, addressed the University of Cincinnati Chapter of Sigma Xi on

February 14 on "A Mathematical Theory of Rational Inference."

The annual meeting of the American Ceramic Society will be held in Columbus, Ohio, from March 29 to April 4. More than a thousand people are expected to attend. The society was organized by the late Edward Orton, Jr., in 1899 and, with the exception of three years, has maintained its national headquarters in Columbus since that time.

Formulation of detailed plans for the joint fiftieth anniversary exercises and sixth quinquennial alumni reunion of the Michigan College of Mining and Technology, Houghton, began on February 1 with the appointment, by the college board of control, of an executive committee consisting of the board and President Grover C. Dillman; a general committee chairman, Dr. James Fisher, head of the mathematics and physics staff and director of geophysical research; a general committee secretary, Treasurer N. F. Kaiser, and twenty-two committees headed by alumni, faculty members, Copper Country citizens and the student council president. The anniversary and reunion ceremonies will be held on August 5, 6 and 7.

Museum News states that a Historic Sites Advisory Board of eleven members, to assist the National Park Service in developing its program for preservation of historic sites and buildings under legislation recently enacted, has been appointed by the Secretary of the Interior as follows: Edmund H. Abrahams, head of the Joint Committee of Memorials of Savannah, Georgia, and of the Savannah Commission for the Preservation of Landmarks; Herbert E. Bolton, chairman of the department of history, University of California; Hermon Carey Bumpus, Duxbury, Mass., vice-president of the American Association of Museums and chairman of the committee on museums of the National Park Service; Mrs. Reau Folk, Nashville, Tenn., regent of the Ladies Hermitage Association; George de Benneville Keim, Edgewater Park, N. J., chairman of the State Commission on Historic Sites of New Jersey; Alfred V. Kidder, Andover, Mass., chairman of the Division of Historical Research, Carnegie Institution of Washington; Fiske Kimball, director of the Pennsylvania Museum of Art, Philadelphia; Waldo G. Leland, Washington, general secretary, American Council of Learned Societies; Archibald M. McCrea, Williamsburg, Va.; F. R. Oastler, New York; Clark Wissler, curator of ethnology, American Museum of Natural History.

In addition to awards already recorded, the Committee on Scientific Research of the American Medical Association has made grants as follows: Lloyd H. Ziegler and Arthur Knudson, Albany Medical College, effect of rickets on the activity of rats; Charles Huggins, University of Chicago, bone marrow in relation to hematopoiesis; Samuel Soskin, Michael Reese Hospital, Chicago, laboratory tests for endocrine dysfunctions; Valy Menkin, Harvard Medical School, iron metabolism and effect of ferric chloride on tuberculosis; Peter Heinbecker, Washington University, St. Louis, mechanism of altered sensitivity of smooth musculature to epinephrine; R. F. Hanzal, Western Reserve University, the source of endogenous uric acid and the effects of methylated xanthines on its secretion; George A. Emerson, West Virginia University, metabolic products of sympathomimetic amines; Felix Saunders, University of Chicago, essential growth factor for bacteria; C. H. Thienes, University of Southern California, carbohydrate metabolism as influenced by the hypophysis; John Field, Stanford University, effect of dinitrophenol on the lens; Ralph I. Dorfman, Louisiana State University, estrogenic substance in human urine and other estrogenics compounds; W. T. Dawson, University of Texas, Galveston, toxicity of cardiac glucosides.

The U. S. Civil Service Commission announces open competitive examinations for the positions of associate public health engineer, at a salary of $3,200 a year, and assistant public health engineer at $2,600 a year. Applications must be on file with the U. S. Civil Service Commission at Washington, D. C., not later than March 16, 1936. Competitors will not be required to report for examination at any place, but will be rated on education, experience and publications.

Short-wave radio sets of the Forest Service type will probably be used to link the scattered units of the Puerto Rico National Forests where other methods of communication are impractical or costly because of frequent hurricanes, rains and the jungle country, according to the Forest Service. The Forest Service's radio system now includes about 1,200 stations on the National Forests of continental United States and Alaska. A. Gael Simson, technical expert in charge of radio for the Forest Service, reports that "the use of radio in the Caribbean National Forest in Puerto Rico is feasible, and from the point of view of emergency communication, it is necessary. Under the present plan for the system, there would be a medium-power main station on each National Forest unit in Puerto Rico in contact with small, light-weight portable sets carried by forest officers or crews of the various Puerto Rican Civilian Conservation Corps camps working in the forests. The National Forest units would also be in touch by radio with U. S. Forest Service headquarters near San Juan.

DISCUSSION

THE CONSERVATION OF PUBLIC LANDS

THE present great enthusiasm for conservation seems to be just another illustration of the old story of covering the well after the cat is drowned; but I suppose we are entitled to all the consolation we can derive from that other old adage, "Better late than never." In this connection it might be of some historic interest to present an unpublished chapter of Bulletin No. 25, of the United States Department of Agriculture, 1901, entitled, "Field Work of the Division of Agrostology." This chapter of the manuscript was returned to the writer by the Secretary of Agriculture, Mr. James Wilson, with the following note: "All too true, but not best for us to take position just now. J. W."

GOVERNMENT CONTROL OF GRAZING LAND

According to the present laws there is no provision for dealing with the vast areas of the public domain which are fitted only for grazing purposes. Provision is made for the disposition in small areas of agricultural, mineral, forest and desert lands which are capable of improvement, while the public grazing lands, which are estimated to include 365,400,000 acres, are left free for the use, or more frequently abuse, of any one who may be able to occupy them. This lack of any system of controlling the grazing lands has led to many serious results and it is already becoming recognized by the more progressive public men and stock raisers throughout the West that some plan should be adopted for controlling these lands. There are various quite evident reasons why steps should be taken in this direction. Under the present lack of control it would seem to be a rational supposition that all citizens of the United States are equally entitled to any advantage which might be gained from occupying these lands, if they are regarded as free and open to all. This feeling on the part of stockmen naturally leads to trouble between different persons wishing to occupy the same territory. These contests not only engender quarrels and bad feeling but frequently lead to serious damage and bloodshed. This is particularly the case in the troubles arising between the cattlemen and sheepmen. Sheep are generally regarded as causing most destruction to the range and leaving it unfit for cattle grazing, and as there is no legal basis for settling disputes of this kind, firearms are sometimes resorted to and slaughter of stock and murder results. Instances of this kind are often brought to our attention. Were this the only evil resulting from the present condition, it alone would be sufficient to justify an investigation and an attempt to adopt some method of remedying the matter. This is, however, but one of the many evils which arise. The effect in retarding the development of the country is also great, especially in relation to the development of irrigation works. Without any means of acquiring right or title to large areas of land, there is little or no inducement to individuals or companies to construct reservoirs, tanks or other works looking toward the irrigation and improvement of large tracts of arid land. The greatest injury, however, at present arising from lack of control is the destruction of the many grasses and forage plants which grow on these grazing lands. Without any means of acquiring a right to graze upon an area except by force or illegal fencing of the range, there is no inducement to one to protect or improve the grazing, while on the other hand there is every incentive to the avaricious person to reap as great benefit as possible from the land in as short a period as possible and then move on to fresher fields. Control of the range land by some to the exclusion of others having equal right to it is frequently secured by the preemption or purchase of the land upon which the available water supply is located, thus making it impossible for others to use the adjoining range.

Of course there are instances where the range lands are at present treated with consideration and with a view to conserving their production, but the general tendency, as shown by the present condition of the grazing lands as compared with their past condition, is to get as much as possible from them without seriously considering the future. The grazing lands as a whole have, according to our observations and reports from reliable sources, become deteriorated to the extent of between 25 and 50 per cent. This means an actual loss in the productivity of the country of many millions of dollars each year. Without means of controlling these public lands there can be no hope for any general or extensive improvement of them. While the investigations of the Division have shown that it is possible to renovate and restore the greater portion of these lands by simple and practical methods, yet there is no inducement for any one to attempt it because they have no assurance of being allowed to profit by the results. Without some method of government control which will insure stockmen the use of the grazing lands for a continuous period sufficient to make it to their advantage to improve and protect the range, there can be little hope that any extensive improvements will be made. On the contrary, the present devastation and destruction will probably in-

crease until the grazing lands are hopelessly destroyed. While the loss to the country in forage each year may be approximately determined, the loss to the country as a whole and its future development and prosperity can not be estimated.

The injurious results of partial or complete denuding of the land are very far reaching. As already pointed out in treating of the Southwest, the normally insufficient moisture supply is greatly decreased by the rapidity with which the rainfall runs off the bare and hardened surface of the soil and also by the great amount of wash and erosion which results from the rapid running of the water. This matter of erosion is also one which affects the irrigation problem, as reservoirs built in such districts fill so rapidly with the silt washed from the bare soil that their usefulness is soon destroyed.

If none of the serious consequences already pointed out could be traced to the present lack of control of these lands, there would still be justification for taking charge of them for purely financial reasons. It is not clear why the government should not derive some revenue from the use of its public lands and any such income might be advantageously expended in the building of reservoirs or other improvements which would facilitate the development of the country. We know of no other country where the government lands are left entirely to the mercy of the squatter.

C. L. Shear

NOTE ON THE PRESENT SUN-SPOT CYCLE

Studies of solar activity as measured by sun-spot numbers reveal that at the end of 1935 solar activity was well on towards the half-way mark between the last minimum and the next maximum. The minimum just passed was reached near the end of 1933, when for thirty-eight consecutive days the Wolfer number was sensibly zero. This occurred five years after the preceding maximum in 1928. On the basis of present indications, the probability is high that the next maximum will be reached in the early part of 1938, making the interval from the last maximum only about ten years.

A study of the nine completed cycles of the last hundred years gives for the mean value of the period of solar activity from the occurrences of minima to be 11.11 years. The average value of the intervals between maxima has been 11.37 years or a quarter of a year more than the average value between minima. Twice during the century there have been as few as ten years between successive maxima in the sun-spot cycle and three times the interval has been as great as twelve years. The interval between minima, on the other hand, has three times been as small as ten years. The interval from one maximum to a succeeding minimum has undergone wide variation, ranging from eight to five years. Three times the interval has been as great as eight years and only once has it been so brief as five years. This was actually the interval between the last maximum and minimum in the present cycle. The average interval from maximum to minimum for the period has been 6.8 years. Calculations show, on the other hand, that the interval from minimum to maximum has ranged from three to five years, the average being 4.3 years.

The interval was only three years from the minimum of 1867 to the maximum of 1870. This is the shortest step in the series between minima and maxima. This was followed by one of the longest steps between maxima and minima, the next minimum following in 1878, or eight years after the previous maximum. The rapidity of the rise in the sun-spot numbers after a minimum appears to be some index for predicting the following maximum. The rapid rise of the sun-spot numbers during 1935 taken together with the very short interval between the maximum of 1928 and the minimum of 1933 would appear to indicate that the next maximum should occur in 1938.

Again, since the last minimum can now definitely be fixed at the end of 1933 (1933.8) and since the average time from minimum to maximum is 4.3 years, it appears that the next maximum should occur in the very early part of 1938. The high value of the sun-spot number (58.8) for the last quarter of 1935 is another indication that we are not far from the half-way point between minimum and maximum. It is suggested that, since the last sun-spot maximum gave high values for solar activity throughout the years 1927, 1928 and 1929, the next maximum may prove to be one with a sharper peak, although at present any exact knowledge is lacking for the prediction of relatively flat or, on the other hand, sharp peaks in the sun-spot curve. The largest group of spots recorded thus far since the last minimum occurred at the end of November and the beginning of December, 1935.

It is to be expected that the rapid change in the solar index during the next two years will be accompanied by magnetic disturbances and generally impaired conditions for distant radio reception in the broadcast band. Studies in field intensities from controlled broadcast stations are being continued at the Institute of Geographical Exploration with the cooperation of three additional stations equipped with field intensity recorders. Two of these lie on nearly the same isogone, and one lies at nearly right angles to its direction.

Harlan T. Stetson

Institute of Geographical Exploration
Harvard University

January, 1936

DEEP-FOCUS EARTHQUAKES AND ISOSTASY

IN a recent discussion[1] Professor W. T. Thom, Jr., wrote: "Pending proof that the deep-focus earthquakes *are* due to ordinary faulting, and are not due to instantaneous rupture produced by deep-seated 'explosions,' it would seem to be in order to consider that their bearing on the problems of tectonics and of isostasy remains indeterminate."

Since the writer had early referred[2] to the possible significance of deep-focus earthquakes for isostasy and has recently been quoted[3] to that effect, a brief statement may here be made.

The mere occurrence of earthquakes at great depths does not in itself prove, as Professor Thom rightly points out, faulting at those depths. It is indeed difficult to imagine faulting at a depth of 500 kilometers, though the question might be raised whether it is essentially more difficult than to imagine it at a depth of, say, 50 kilometers. Perhaps the main reason for greater difficulty in the first case is that we are accustomed to think of high temperatures and zero strength for the rocks at great depths. But is such low or zero strength a demonstrated fact?

The writer is far from assigning "ordinary faulting" as the cause of the deep-seated shocks and looks rather to the high-pressure experiments of Professor Bridgman as pointing to a solution. There is, however, one feature of the seismographic records of at least some of the deep-focus earthquakes that may again be referred to here. In a study of the earthquake of March 29, 1928, it was stated: "The apparent predominance of shear waves must be taken into account in any hypothesis that one might put forward in regard to the mode of origin of a shock at so great a depth as 410 kilometers. The records would seem to preclude anything in the way of a mere explosive activity."[2] The same prominence of the shear waves is found in a study now being made of the shock of June 29, 1934. This is the deepest earthquake reported thus far, having a focal depth of nearly 700 kilometers.

Again, if the source were an "explosion," one might expect the direction of motion of the first impulse to be generally the same. However, no such consistency appears. Thus, of 101 shocks in the interval from April, 1932, to April, 1934, qualified in the Bulletin of the Seismological Laboratory at Pasadena as "deep," 61 showed the first impulse as a compression and 40 as a dilatation.

The apparently limited geographical distribution of deep-focus earthquakes—though perhaps we still know too little on this point—would seem to indicate a lack of spherical homogeneity in the earth at rather great depths. It may be asked whether such homogeneity at depths of several hundred kilometers, while probably not essential, has not been at least implicit in the isostatic picture of the earth's interior.

While, then, it may be said that, for the time being, the bearing of deep-focus earthquakes on "the problems of tectonics and isostasy remains indeterminate," it may also be urged that deep earthquakes must find a place in any complete theory of the earth's interior, of its structure, constitution and development.

V. C. STECHSCHULTE

XAVIER UNIVERSITY, CINCINNATI

[1] SCIENCE, 83: 2141, 32, January 10, 1936.

[2] *Bull. Seis. Soc. Amer.*, 22: 2, 81–137, June, 1932.

[3] J. S. De Lury, *Jour. Geol.*, 43: 7, 763, October-November, 1935.

THE NEW ERGOT ALKALOID

DURING the first half of the year 1935 communications appeared from four different laboratories, in three different countries, each describing the discovery and isolation of a new alkaloid from ergot, very different in its properties from those previously known. These communications dealt with researches which had been proceeding concurrently and independently, and in each case the authors gave a name to the alkaloid which they had obtained, so that four new names were put forward—Ergometrine,[1] Ergotocin,[2] Ergobasine[3] and Ergostetrine.[4] There was an obvious general resemblance between the substances thus variously named, but preliminary analytical indications and certain minor discrepancies in the earlier published physical constants and chemical properties left some doubt as to whether the four were really identical or only closely related alkaloids. Later and more detailed publications have removed most of these discrepancies. It appeared to us, however, that the question of identity ought to be settled finally by an exchange of specimens, a careful comparison of them in the laboratories concerned and, if possible, an agreed statement of the resulting conclusion. This exchange and comparison have now been carried out by the undersigned, of whom H. King has acted in the place of the late H. W. Dudley (who died on

[1] H. W. Dudley and C. Moir (Ergometrine), *Brit. Med. Jour.*, i: 520, 1935; SCIENCE, 81: 559, 1935. H. W. Dudley (Ergometrine), *Proc. Roy. Soc. London*, B. 810, 116; 478, 1935.

[2] M. S. Kharasch and R. R. Legault (Ergotocin), SCIENCE, 1935, 81: 388 and 614; *Jour. Am. Chem. Soc.*, 57: 956 and 1140, 1935; M. E. Davis, F. L. Adair, G. Rogers, M. S. Kharasch and R. R. Legault, *Am. Jour. Obstet. and Gynec.*, 29: 155, 1935.

[3] A. Stoll and E. Burckhardt (Ergobasine), *C.r. Ac. Sc.*, 200: 1680, 1935; *Bull. Sci. Pharmacol.*, 42: 257, 1935.

[4] M. R. Thompson (Ergostetrine), *Jour. Am. Pharm. Assoc.*, 24: 24 and 185, 1935; SCIENCE, 81: 636, 1935.

October 3, 1935). Our comparisons of the melting points and mixed melting-points of the four alkaloids and of certain of their salts, and of their optical activities in different solvents in cases where sufficient material was available, leave us in no doubt that the alkaloid obtained in the four different laboratories was the same substance, and that the four names given to it are synonyms. Having reached that conclusion, we are content to leave to the world of science the choice of one of these names, for adoption into scientific literature as the recognized name of the one alkaloid.

M. S. KHARASCH
H. KING
A. STOLL
MARVIN R. THOMPSON

SCIENTIFIC BOOKS

INSECT ENEMIES OF SHADE TREES

Insect Enemies of Shade Trees. By GLENN W. HERRICK. Pages i–viii, 1–417, 350 text illustrations. Comstock Publishing Company, Ithaca, New York. 1935.

THIS latest addition to our knowledge of the insects of shade trees is by one who has added materially to our knowledge of this large group. The book is an attractive, moderate-sized volume containing brief practical accounts of the more injurious insect pests affecting trees and shrubs. It also lists many others which are not deemed of sufficient importance to warrant a paragraph, though for most of these there is no clue as to where information concerning them may be found.

There is first of all a discussion of the value of shade trees and general methods of protection from insect attack, followed by a chapter devoted to a consideration of the materials and apparatus for the control of tree and shrub insects and a third is concerned with suggestions for treatment of weakened trees. This last is important, since it is becoming increasingly evident that the vigorous tree is less likely to suffer from insect pests and in not a few cases it is able to resist attack. This is particularly true of the deadly enemies of the cambium, such as the bronze birch borer, the two-lined chestnut borer, the hickory bark beetle and the hemlock borer. It is the belief of the reviewer that the intimate relation existing between repeated defoliation, poor growing conditions, sudden changes in the supply of moisture, including drought, can not be emphasized and re-emphasized too much since they are fundamental to any system which would keep trees vigorous. This is recognized by the author, though hardly emphasized sufficiently. It is gratifying to note that both in this volume and in large scale control work on shade tree insects by governmental and state agencies, tree sanitation is becoming more generally recognized as an important method of tree conservation. Another matter which might have been brought out is the difficult growing conditions for trees on lawns, due to the fact that there is comparatively little enrichment of the lower soil layers and the reduced humus incident to repeated mowing, both greatly favoring drought extremes.

The larger portion of the volume is devoted to a discussion of the insect enemies of the more important trees, such as the ash, beech, birch, buckeye and horsechestnut, catalpa, elm, ginkgo, hackberry and so on down the list to the willow. The apple and cherry, both of value as ornamentals as well as for fruit, are conspicuous by their absence. An interesting innovation is a preliminary consideration of the characteristic qualities of each of the shade trees discussed in the various chapters.

There is a separate chapter dealing with the insect enemies of smaller trees and shrubs, another devoted to evergreens other than pines and a final one restricted to miscellaneous enemies of trees and shrubs. It appears to the reviewer that it would have been more logical to have included the accounts in these last three in chapters devoted to the other trees, even if the divisions were relatively short. An informative book of this character is successful in proportion to the accessibility of the information to the average reader. He knows little and usually cares less about taxonomic relationships. This, however, is more or less a matter of opinion.

Greater familiarity on the part of the author with recent literature would have made possible a definite statement as to the wintering habits of the hickory gall aphid, an appreciation of the fact that the elm lace bug rarely attacks valuable trees, since these latter are seldom surrounded by the bushy or woody growth necessary to the hibernation of this insect and there is therefore little real need of suggesting a spray for this insect, that injury by the Pales weevil to the roots of good-sized Scotch pines may greatly outweigh the earlier recognized damage to seedlings and that methods of controlling the two more common hackberry psyllids of the north are already known. We question the need or efficacy of the measures recommended for the control of the pigeon horn-tail. The treatments commonly advised for injurious borers are far from satisfactory, due in large measure to inherent diffi-

culties and the fact that no one has been able to give the problems the study they deserve. There are brief accounts of two western cypress bark beetles and no mention of the closely related eastern bark beetle of our junipers and red cedars. These are all relatively minor points and illustrate the great difficulty of bringing into a completed whole the hosts of facts having a vital bearing on the control of hundreds of insects.

There is a feeling on the part of the reviewer that the author has been over-conservative in some of his statements in regard to control measures. There are some definite recommendations, but in a number of cases these are prefixed by the somewhat over-cautious phrase, "It is said," or words to that effect, a caution hardly necessary in connection with the golden oak scale, a pest successfully controlled with oil sprays for more than a decade. A general consideration of the measures advised leads the reviewer to the conclusion that much work has yet to be done before our knowledge of the insect enemies of shade trees and ornamentals is sufficiently extended and exact to permit definite control recommendations for many of these pests. This last is not a criticism of the volume. It is a recognition of a need which various research agencies engaged in the study of the insect enemies of shade and ornamental trees are endeavoring to meet as rapidly as possible.

The general reader will find the long series of excellent and largely original illustrations exceedingly helpful in identifying the various species. The reviewer was especially attracted by the illustrations of the eggs of a number of species of cankerworms, though he regrets that in the interest of completeness the author did not see fit to include an egg mass of the fall cankerworm, a most important pest in this group. The book is excellent and well adapted to the requirements of superintendents of parks, members of shade tree commissions and others interested in conserving those very important natural resources of the country known as shade and ornamental trees.

E. P. Felt,
Director

Bartlett Tree Research Laboratories

COLLEGE PHYSICS

College Physics. By Mendenhall, Eve and Keys. 592 pages, Boston, D. C. Heath and Company.

In view of the great loss to physical science in the death of Professor C. E. Mendenhall, this text-book deserves special consideration. It is an elementary book suitable for a thorough first course of university or college grade. The material is presented somewhat in the traditional order and in the general divisions of mechanics (solids and fluids), sound, heat, magnetism and electricity, and light, with three additional chapters on modern physics. The study of dynamics precedes statics, giving the student a chance to get some acquaintance with the subject before he has to tackle the almost universal bugbear of problems on the equilibrium of particles and of rigid bodies. In dynamics absolute c.g.s. units are used along with the similar absolute f.p.s. system in which the poundal is the unit of force, foot-poundal of energy, etc. This treatment is logically satisfying and allows the use of the same equations for the two systems of units. The more familiar English gravitational units (pound weight, foot-pound, horsepower, etc.) are also given and the everyday use of them is stressed in illustrative examples and in the problems. Answers to problems are given in both ways, *i.e.*, poundals and pounds, foot-poundals and foot-pounds, etc. The student of this text must, however, stick to poundals for force in the equation, $f = ma$, and in all relations derived therefrom, and afterwards translate his results to pounds. Whether this procedure is superior to the open use of British engineering units and the total ignoring of the practically never used absolute f.p.s. system is a question always good for almost endless discussion among teachers of elementary physics.

In magnetism and electricity the student gets acquainted, as he should, with both fundamental c.g.s. systems, e.s.u. and e.m.u., and with the practical units, defined in terms of the latter. Certain legal definitions, as such, are also given. Besides the usual elementary classical electricity, two chapters are given over to more recent developments, such as conduction in gases, x-rays, vacuum tubes, radio and television, etc.

Modern physics is discussed at such length as the authors deemed advisable in three final chapters, on photoelectricity, radioactivity and atomic structure. This discussion is up-to-date, accurate, and yet given in sufficiently simple language for the student to grasp it and have his curiosity aroused. Besides this discussion of modern physics, modern concepts are used and modern developments are described throughout the text. In fact, the point of view is not only up-to-date, but at the same time gives the student some idea of how physics grew and how it is growing. This is considerably assisted by including in the first chapter a brief historical summary and by following names of men with dates of birth and death in parentheses.

The writers' style is very clear. They have been at some pains in many instances to anticipate the student's pitfalls, explaining with great care points which usually give trouble. The mathematical knowledge required is such as is usually covered in a freshman course in mathematics. Calculus is not used. The more difficult sections are starred, instead of being put

in the customary fine-print, which usually leads the student to ignore them. There are more than thirty tables scattered through the text and an additional three-page "Table of Reference" at the close of the book.

Altogether, the authors have produced a text-book of a high grade of excellence which, while it is on the whole conservative in the arrangement and treatment of the material, never loses sight of the aliveness of the subject and gives the student a glimpse of what lies beyond the elementary groundwork. It should prove in all respects a most teachable text.

E. P. T. Tyndall

State University of Iowa

REPORTS

THE THIRD ANNUAL TRI-STATES (ILLINOIS, WISCONSIN, IOWA) GEOLOGICAL FIELD CONFERENCE

The geologists and students of geology in the three states mentioned in the title were invited to the annual Tri-States Field Conference on November 16 and 17, 1935. The conference was held this year in Clinton, Jackson and Dubuque counties in eastern Iowa. It was conducted by A. C. Trowbridge, assisted by A. C. Tester and M. L. Thompson.

There were in attendance 124 persons, who traveled in 34 cars. Eleven colleges and universities, two state geological surveys and one oil company were represented.

The geology of routes and stops was described in a nine-page mimeographed log and a blue-print map, handed to each participant at the beginning of the conference.

Leaving Clinton, Iowa, at 9:00 A.M. on Saturday, the cavalcade arrived at Dubuque, Iowa, at 5:30 P.M., having traveled 123 miles and made 11 stops for the study of geologic features. On this day's trip all stratigraphic horizons from the top of the Ordovician Dubuque dolomite to the top of the Silurian Hopkinton dolomite were seen. The section at Bellevue in Jackson County was of special interest, because of the difficulty of classifying it. The uppermost beds of the Dubuque dolomite are exposed at the base of this section, and beds of Kankakee or Hopkinton age at the top.

Also, Kansan till, the basal portion of almost completely eroded Yarmouth gumbotil, an Illinoian channel of Mississippi River connecting Maquoketa and Wapsipinicon rivers, Peorian loess, and a hill at Fulton, Illinois, cut off from the Iowa bluff by Mississippi River in Wisconsin time, were observed and discussed.

In addition, caves, sinks and natural bridges in Hopkinton dolomite were visited near Maquoketa, Iowa, and the party inspected Crystal Lake Cave that was also once a lead mine, near Dubuque.

The Saturday route crossed an inlier of Maquoketa shale in the Preston anticline in southern Jackson County.

A general meeting was held in Dubuque on Saturday night. No scientific papers were presented, but the geologic problems of the area were freely discussed. By separate vote of members of the three state groups, A. H. Sutton was elected to succeed M. M. Leighton as member of the executive committee for Illinois, F. T. Thwaites to succeed W. H. Twenhofel for Wisconsin, and A. C. Tester to succeed A. C. Trowbridge for Iowa. As the conference will be held in Illinois in 1936, Dr. Sutton is chairman of the executive committee for one year.

On Sunday, November 17, the Ordovician Saint Peter, Platteville, Decorah and Galena formations and their subdivisions were studied at Dubuque, and in a famous section at Spechts Ferry. The party also drove through Couler Valley and visited a good exposure of Nebraskan drift capping a high Mississippi River bluff, at Dubuque.

There is evidence that in pre-Nebraskan time the Mississippi River drained a peneplane and flowed in a wide, shallow valley about 75 miles west of its present course; that it was forced to take its present position along the east border of the Nebraskan glacier; that it was intrenched in this course following regional uplift; that Little Maquoketa River, a tributary to the Mississippi, developed Couler Valley; that in about Kansan time Couler Valley was abandoned by diversion through piracy of Little Maquoketa River to the Mississippi above Dubuque; that by Wisconsin time Mississippi and Little Maquoketa rivers had so deepened their valleys as to leave Couler Valley hanging about 250 feet above the master stream at both ends; that Couler Valley was again occupied by Little Maquoketa River and by a part of the Mississippi River when it carried Wisconsin glacial water and deposited glacio-fluvial material in its own valley and in Couler Valley; that water continued to flow through Couler Valley for a time after the retreat of the Wisconsin glacier while part of the fill was being removed; and that still later the Little Maquoketa was again diverted directly to the Mississippi, and Couler Valley was again left without a stream as it is to-day.

The conference closed at Dubuque at noon on Sunday.

A. C. Trowbridge

University of Iowa

SPECIAL ARTICLES

THE BAR "GENE" A DUPLICATION

THE nature of the Bar gene has been the subject of extensive investigation and speculation since February, 1913, when Tice[1] found this reduced-eye mutant as a single male in the progeny of normal-eyed parents. The eye-reduction behaves as a sex-linked dominant, with a locus at 57.0, and has been one of the most important of all the sex-linked characters of *D. melanogaster*. A remarkable peculiarity of the mutant is that occasionally the homozygous stock gives rise to a fly indistinguishable in appearance and genetic behavior from wild-type.[2] More rarely the stock gives rise to an even more extreme reduction in eye-size, a type which was called Ultra-Bar by Zeleny,[3] who found it.

Sturtevant and Morgan[4] and Sturtevant[5] found that these two-way changes were the result of a novel type of "'unequal" crossing-over, by which the two genes originally present in the two parental chromosomes both emerged in the same chromosome (Bar-double) while the other resultant chromosome was without Bar (Bar-reverted). The change from Bar to Bar-double was considered to be a single gene duplication, while the converse change, from Bar to Bar-reverted, corresponds to a one-gene deficiency. Since the Bar-reverted type proved to be indistinguishable from the normal unmutated wild-type, the gene present in Bar and lost in Bar-reverted must have itself correspond to a new addition or one-gene duplication.[6]

Sturtevant[5] found the unexpected relation that two Bar genes in the same chromosome (BB/B^+) gave a greater reduction in the size of the Bar eye than did two Bar genes in opposite chromosomes (B/B), an intensification of action which he formulated as a "position effect." Dobzhansky[7] interpreted his allelic Baroid mutant as a position effect due to the substitution of material at or near the Bar-locus (in the normal X) by material translocated from the right limb of chromosome 2, and the reduction in the Bar eye to the interaction between a gene in the X chromosome and the duplication.

A chance to clear up some of the puzzles as to the origin and behavior of Bar was offered by the salivary chromosomes. Study of the banding in a stock of Bar (forked Bar) showed that an extra, short section of bands is present in excess of the normal complement, forming a duplication. The insertion point of this duplication is in the bulbous "turnip" segment, not far from the basal end of the X.[8]

1 S. C. Tice, *Biol. Bull.*, 26: 221–51, 1914.
2 H. G. May, *Biol. Bull.*, 33: 361–95, 1917.
3 C. Zeleny, *Jour. Exp. Zool.*, 30: 293–324, 1920.
4 A. H. Sturtevant and T. H. Morgan, SCIENCE, 57: 746–7, 1923.
5 A. H. Sturtevant, *Genetics*, 10: 117–47, 1925.

The exact point of the insertion is ambiguous, for a reason which will appear below. The normal X in this region (see revised map in Fig. 1) shows in sub-sec-

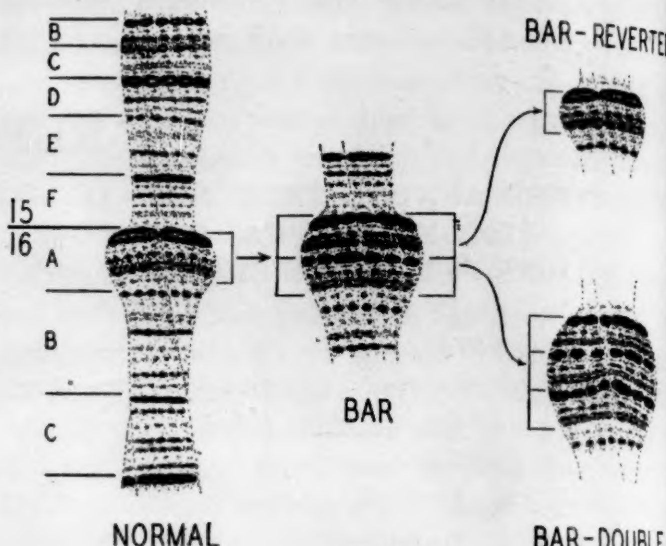


FIG. 1

tion 16A a heavy band, which in well-stretched chromosomes, or with certain fixations, is a clear doublet, usually with the halves united in a capsule, but occasionally completely separate. This is followed by a very faint dotted line, which can be seen only in the most favorable conditions. Next follows a fairly weak line which is distinctly "dotted" in texture, with the separate dots loosely connected across the width of the chromosome. Next follows closely a still fainter, diffuse, continuous-textured doublet, with the doubleness generally appearing as mere broadening. The last line of sub-section 16A is again a very faint dotted singlet. Sub-section 16B starts with a sharply discontinuous line of fairly heavy dots or vesicles and is a line very easy to recognize. The greatest width of the bulbous segment 16A is at the two fairly weak bands, while a very sharp change in size occurs at the transition from 15F to 16A.

In the Bar chromosome the condition may be described observationally as the repetition of section 16A, with the exception of the final very faint dotted line. But the whole region of this bulb has undergone changes in the Bar chromosome as follows: the "puff" of the bulbous segment is more pronounced and its size is increased; the banding is more discontinuous by being broken into blocks and vesicles, and the regularity of synapsis is disturbed by oblique junctions. Thus, in Bar the heavy doublet following the last faint dotted line of 15F is more segmented than normal and more rarely shows its doubleness clearly. This tendency is more pronounced in the heavy broken line of

6 S. Wright, *Amer. Nat.*, 63: 479–80, 1929.
7 Th. Dobzhansky, *Genetics*, 17: 369–92, 1932.
8 C. B. Bridges, *Jour. Hered.*, 26: 60–4, 1935.

the repeat seriation to the right. All the lines of the repeat seriation to the right differ from the corresponding lines of the initial seriation by being somewhat less intense, more broken, more diffuse and more confused in their synapsis relations.

In a forked non-Bar stock recently derived from the above forked Bar stock by breeding from the rare Bar-reversions, the banding was found to be precisely identical with that of unrelated normals as far as could be observed in excellent permanent preparations of well-stretched chromosomes.

In a forked Bar-double stock, similarly derived from the same f B stock by breeding from the very rare "Ultra-Bar" type of eye, it was found that the extra section observed in Bar was present still again, giving a thrice-repeated seriation in direct sequence. The changes differentiating Bar from normal were carried further in Bar-double, as follows: The size and puffiness of the bulbous regions was still greater, as well as the blockiness of the banding and irregularity and obliqueness of the synapses. These disturbances were greatest in the middle one of the three seriations.

These findings enable the Bar "gene" to be reinterpreted as a section of inserted genes—a duplication. The production of Bar-double and of Bar-reverted is seen to be the insertion of this extra section twice, or conversely, its total loss—both presumably by a process of unequal crossing-over. That the section of bands should behave as a unit in this process is perhaps accounted for by the observation of oblique synapsis, especially frequent in Bar-double, where presumably one entire sequence synapses with another of a different position in the series of three. The oblique synapses were even more frequent in BB/B^+, where one series in B^+ has a choice of three series in BB, apparently usually synapsing with one or the other end series.

According to this interpretation the source of the duplication is the material directly adjacent to the repeat. But whether the point of insertion preceded the heavy doublet of 16A1 or the very faint final singlet of 16A5, can not be determined. If Bar is itself a repeat, a reason is thereby provided for its unique behavior of giving rise to Bar-double and Bar-reverted by oblique synapsis. Perhaps half of the Bar-reversions carry the original series and the other half the subsequent repeat restored to its original position.

On this interpretation, the "position effect"—the reinforcement of the action of one Bar gene by another in direct sequence next to it—has a visible cytological accompaniment in the increased size and puffiness, and the change in the character of the banding of both series in Bar as compared with normal and of all three series in Bar-double as compared to Bar itself. Part of this is presumably due to the "rounding-up" tendency of the synaptic attraction *along* the chromosome in addition to the oblique attractions and the straight-across attractions.

The Bar-eye reduction is thus seen to be interpretable as the effect of increasing the action of certain genes by doubling or triplicating their number—a genic balance effect. But "position effects" are never excluded when duplications or other rearrangements are present, either in the wedging further apart of genes normally closer, or by the interaction with new neighbors. The respective shares attributable in the total effect to the genic-balance change and to the position-effect change seems to be at present a matter of taste.

Study of the Baroid translocation apparently shows that the break in X comes between the two halves of the heavy doublet of 16A1. The break in 2R follows directly after the heavy capsular doublet of 48C1. Thus a demonstrable basis is laid for Dobzhansky's interpretation of the Baroid eye-reduction as a position effect.[7]

The previously reported finding[8] of the presence of "repeats" as a normal part of the chromosomes of *D. melanogaster*, and the suggestion that unequal crossing-over is probably the mechanism of production of some short repeats, thus have received ample verification by these direct observations on these processes in the case of Bar and its derivatives.

Calvin B. Bridges

California Institute of Technology,
February 21, 1936

A NEW METHOD FOR TESTING THE SENSE OF SMELL AND FOR THE ESTABLISHMENT OF OLFACTORY VALUES OF ODOROUS SUBSTANCES

In a series of experiments we have found that if odors are injected into the nasal passages in sufficient volume and with sufficient force, they can be recognized even when the breath is being held, and in papers recently published[1] two procedures for the examination of the sense of smell were described, which are based upon this new principle.

The apparatus used consists of a wide-mouthed bottle, which is closed by a rubber stopper through which pass glass inlet and outlet tubes. The end of the outlet tube has a rubber connection for the attachment of a nosepiece, and the rubber connecting tube is closed by an ordinary pinchcock. The nosepieces are Y shaped, so that the nosetips at the ends of the branches of the Y can be inserted into the nostrils. In

[1] *Bulletin* of the Neurological Institute of New York, Vol. IV, Nos. 1 and 2, 1935.

one nosepiece the lumen of one branch of the Y is obliterated, while in the other both lumina are patent. By the use of the appropriate nosepiece, odor can be injected from the bottle into one or into both nasal passages.

The test bottle has a capacity of 530 cc and contains 30 cc of the odorous substance with a 500 cc space above it. Air is injected into the bottle through the inlet tube by means of a calibrated glass syringe and released into one or both sides of the nose by pressure on the pinchcock which surrounds the outlet tube. By the injection of air into the bottle, and release of the blast into the nasal passages while the subject who is being examined holds his breath, the air is carried to the olfactory membrane and the force of the injection takes the place of the inspiratory movement of ordinary breathing. At regular intervals an amount of air and odor is injected into the nasal passages until the number of cubic centimeters is ascertained by which the odor can be identified by the subject. This procedure was called the Blast Injection Test. The smallest number of cubic centimeters of an odor that can be identified by this procedure with a test bottle of the size used was called the M.I.O. (minimum identifiable odor), and the M.I.O. upon bisynchronorhinal injection was called the olfactory coefficient of the odorous substance. As each odorous substance has its own olfactory coefficient, it was possible to classify odors on this new principle, and it was found that the olfactory coefficients varied directly with the boiling points of the odorous substances, and therefore inversely with the vapor pressures.

In the procedure of blast injection of odors the volume of the injected odor and its pressure are known. It was therefore possible to investigate the relative importance of volume and pressure of the olfactory stimulus and to conclude that for the perception and identification of an odor, the force with which the odor impinges upon the olfactory cells in the superior meatus of the nose is of more importance than the volume that is injected.

The olfactory acuity of each side of the nose was studied separately by means of the nosepiece which permitted the injected odor to reach only one side, and the acuity of birhinal smell was studied by means of the nosepiece through which odor was injected into both nasal passages.

In a second procedure which was called Stream Injection, the odor was injected into one or both nasal passages in a continuous stream for various periods of time, and at varying volume-rates, while the subject was breathing through the mouth. This is accomplished by means of a tank of compressed air, the outflow from which is controlled by a gage. The outlet from the tank is connected to the test bottle which contains the odorous substance (after the pinchcock has been removed) and during the test air and odor flow from the test bottle into the nasal passages.

The procedure of stream injection was found to be of value both for the study of olfactory fatigue and for investigations of the trigeminal effects of odorous substances. The odorous substances whose effects were purely olfactory could be distinguished from those that affected also the trigeminal nerve, and it was found that many substances hitherto believed to be pure olfactory stimulants have an effect upon both the olfactory and the trigeminal nerves.

By means of the stream injection of odors it was possible to produce olfactory fatigue of different duration, and then by means of blast injection tests to determine the relation between the duration and volume-rate of the stream injection and the depth and duration of the resulting fatigue, and to gain some insight into the nature of olfactory fatigue and the parts of the brain responsible for this alteration of function. The fatigue produced by the stream injection of an odor was mainly specific for the odor used, but fatigue for one odor also caused some diminution of the acuity of smell for other odors.

By the use of blast and stream injections, we were able to study the effect of unilateral olfactory stimulation upon birhinal acuity of smell, and the effect of bilateral stimulation upon monorhinal acuity of smell.

These olfactory tests were applied in patients with tumors of the brain. The small series of tests thus far made showed that when the M.I.O. of one or both sides of the nose was high, while the fatigue produced on both sides was not prolonged beyond what is normal, the growth was small and so situated on the under surface of one or both frontal lobes as to make pressure upon one or both olfactory bulbs and tracts. When the M.I.O. was within normal limits or lower than normal, and the fatigue was prolonged on one side, the tumor was within the substance of the cerebral hemisphere and on the same side as that on which there was increased fatigability. By these procedures, therefore, it was possible to gain information regarding the situation of the growth.

The tests made upon normal individuals and upon patients with tumors of the brain demonstrated that olfactory fatigue was not due to a refractory state of the olfactory receptors or of the olfactory bulbs and tracts, but was the result of an abeyance of function in the receptive and memory centers for smell in the brain itself.

CHARLES A. ELSBERG
IRWIN LEVY
EARL D. BREWER

NEUROLOGICAL INSTITUTE
COLUMBIA UNIVERSITY

SCIENTIFIC APPARATUS AND LABORATORY METHODS

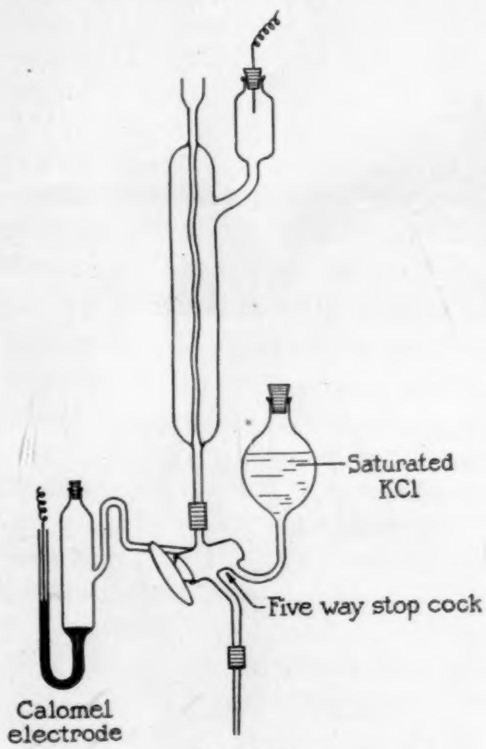
GLASS ELECTRODE WITH GALVANOMETER READING[1]

THE successful development of the use of the glass electrode for pH measurement has depended on the use of electrostatic instruments, either electrometers of the quadrant type or related instruments or electronic valve devices. The high resistance of the glass membrane has discouraged the use of the potentiometer with a galvanometer as zero instrument in spite of the otherwise considerable advantages of such an outfit as to simplicity in equipment and handling. In this laboratory we succeeded in building a relatively simple glass electrode device with galvanometer reading which has proven most satisfactory for more than two years. The problem was solved simply by lowering the resistance of the glass membrane as much as possible and using a sufficiently sensitive galvanometer.

The glass electrode used is essentially the sealed-in type described by MacInnes and Belcher.[2] It is made of the same type of glass and differs from the original model only by the shape and thickness of the glass membrane. The wall of the glass membrane is as thin as the glassblower could manage to make it, and the shape of the inner tubing is not a spiral but almost straight, just a little curved to obviate strains in the glass. The length of this inner tube varied, in different samples of the electrode, from 25 to 40 cm and its volume from 3 to 5 cc. The thinness of the wall has not only the advantage of lowering the resistance but also of abolishing the asymmetry potential. Such an electrode, after two or three days' contact with aqueous solutions, has as a rule practically no asymmetry potential. The resistance amounted in various samples to from 4 to 10 megohms. Samples of somewhat higher resistance can be used, but the sensitivity may not be sufficient for all purposes.

This electrode was used in combination with an ordinary potentiometer and a galvanometer. The type of galvanometer usually used with the Leeds and Northrup potentiometer, Type K, is not sensitive enough. We used a galvanometer of the Cambridge Instrument Company which is critically damped by an external shunt of 20,000 ohms (the permanent shunt built into the Type K potentiometer must be removed, and a shunt of 20,000 ohms across the galvanometer used instead), and has a period (when undamped) of 10 seconds. The sensitivity is such that 1 mm deflection in 1 meter's distance corresponds to 2.5×10^{-10} amperes. Under these conditions 1 millimeter deflection corresponds, for electrodes of the above mentioned low range of resistance, to from 1 to 2 millivolts. So it is easy to read the millivolts and to estimate the tenths of a millivolt. Several such electrodes are in permanent use in this laboratory. They are mechanically astonishingly resistant and practically unbreakable, as the delicate parts are entirely sealed in.

Two types of set-up are in use in this laboratory. Type I is used to measure pH in a sample of a liquid. It is quite convenient to equip it with MacInnes' and Belcher's five-way stop-cock for the establishment of fresh liquid junctions. The solution is poured in from above. Three to six cc are necessary, according to the volume capacity of the glass tube. If only less liquid is available, it is sufficient to fill the tube only to a half or less, provided the whole tube has been well rinsed by the liquid when pouring it in. The result is not altered whether the tube is entirely full or not. Type II is used for acidimetric titrations. The samples of the liquid are sucked into the glass tube from the beaker.



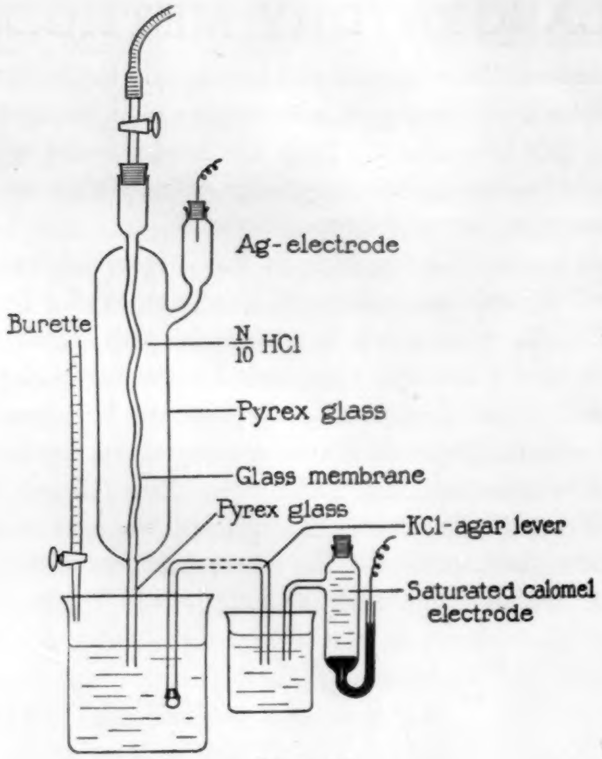
TYPE I

The outer compartment is permanently filled with 1/10 N HCl, containing a chlorinized silver electrode.[3] This solution is never changed. Each set of experiments begins with the measurement of a sample of standard acetate (100 cc N NaOH, 200 cc N acetic acid, filled up with H_2O to 1 liter). A stock solution of this buffer keeps unchanged over many months. Its pH is taken = 4.62 and used as reference value. The slope of the potential against pH is within the limits of error the one thermodynamically expected for a reversible hydrogen electrode at least within pH 1 and 9, and even to pH 11 the deviations are very small.

[1] From the laboratories of the Rockefeller Institute for Medical Research, New York.

[2] D. A. MacInnes and D. Belcher, *Ind. and Eng. Chem.*, Analytical Edition, 5: 199, 1933.

[3] Alfred S. Brown, *Jour. Amer. Chem. Soc.*, 56: 646, 1934.



TYPE II

The correctness of the slope is shown in the following experiment.

A solution containing 1 mole NH_4Cl per liter, and NH_3 in the concentration indicated in the table showed the following potentials at 30° C. = (in a constant temperature room).

$[NH_3]$	Electrode I, 7 megohms (filled with .1 N HCl)	Difference	Total difference	Electrode II, 4 megohms (filled with .5 N HCl)	Difference	Total difference
.001000	.2566			.3109		
		.0602			.0598	
.01000	.3168			.3707		
		.0600	.1805		.0601	.1802
.1000	.3768			.4308		
		.0603			.0603	
1.000	.4371			.4911		

The difference should be theoretically in each case .0601 volts; and the total difference over three units of pH is theoretically .1803 volts. This table is taken from measurements made by Dr. J. Bjerrum in this laboratory, who has used this glass electrode for various investigations to be published later.

Except on very warm and humid summer days, no trouble of any kind was encountered in the use of this method.

LEONOR MICHAELIS

A SIMPLIFIED PROCEDURE FOR THE VOLUMETRIC MEASUREMENT OF SERIALLY SECTIONED STRUCTURES

BIOLOGISTS have frequently been able to determine the volume of glands, etc., too small or diffuse to be otherwise handled by outlining serial sections and measuring the outlines either by cutting out and weighing or by use of a draftsman's planimeter. The use of this latter instrument is somewhat simpler, though in either case the method is laborious.

In extensive use of this technique the author has found it possible to so simplify the procedure that, aside from the preparation of the slides, very little effort is involved.

The outlines, by projection or camera lucida, are prepared in sequence on a continuous sheet of wrapping paper. The planimeter is set upon a large sheet of heavy clear celluloid (or other thin flat transparent material) which is tacked down at the ends. A pinhole near the center is made and marked as the starting point. The celluloid sheet should be large enough so that in all measurements the planimeter rides entirely upon it.

The sheet with outlines are slipped *under* the celluloid and a point on the first perimeter is brought under the starting point. The pointer is traced around, measuring the first outline. Then without disturbing the planimeter the outline sheet is slipped along until a point on the next outline is under the starting point. When this is measured the planimeter automatically adds its area to that of the preceding. If it is desired to subtract any particular part of the outline the planimeter is run backwards. The final sum of the areas is given by one reading of the planimeter. From this and the thickness of the sections the volume is calculated.

By this method a gland involving over one hundred sections can be carefully outlined, measured and checked in less than two hours. A comparison with the paper weight method showed somewhat less variability and the further advantage of giving actual volumes.

WILLIAM ETKIN
COLLEGE OF THE CITY OF NEW YORK
AND
THE AMERICAN MUSEUM OF NATURAL HISTORY

BOOKS RECEIVED

CRILE, GEORGE. *The Phenomena of Life: A Radio-Electric Interpretation.* Pp. 379. 113 figures. Norton. $3.50.

EDGEWORTH, F. H. *The Cranial Muscles of Vertebrates.* Pp. viii + 493. 841 figures. Cambridge University Press, Macmillan. $30.00.

PETERS, J., A. LODGE, E. J. TERNOUTH and E. GIFFORD. *Mathematical Tables.* Vol. V: *Factor Table: Giving the Complete Decomposition of All Numbers Less than 100,000.* Pp. xv + 292. British Association for the Advancement of Science. Cambridge University Press, London. 20/–.

STOKLEY, JAMES. *Stars and Telescopes.* Pp. xiii + 319. 40 figures. 49 plates. Harper's. $3.00.